Utanríkisráðuneytið

Atvinnuvega- og nýsköpunarráðuneytið

Economic implications of the introduction of paratuberculosis in cattle in Iceland

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March 2014

Introduction

This analysis builds on Dr. Preben Willeberg´s report "Risk assessment regarding open trade in live animals to Iceland", commissioned by Icelandic authorities. The objective of the analysis is to estimate the cost of a possible spread of paratuberculosis to cattle herds in Iceland following the lifting of the moratorium on import of live animals. The cost calculations are based on a set of assumptions regarding probabilities of an infection, long-term herd prevalence and production loss caused by the disease. Results are calculated for two different scenarios[1] and based on available literature on the consequences paratuberculosis in cattle. It is worth emphasizing that the results are limited to paratuberculosis in cattle and do not constitute an overall assessment of the economic consequences of lifting the moratorium on imports of live animals. Lifting the moratorium will open for the introduction of numerous other deceases, some of which are discussed in Willeberg´s report. Many of those will have economic consequences, ranging from minor to substantial depending on the decease and the effected animals. The outbreak respiratory tract infection in the Icelandic domestic horse population in 2010 showed that minor illnesses can cause significant economic losses when initially introduces. It is furthermore worth emphasizing that the possible benefits of importing live animals to Iceland are not estimated, which in some instances could be significant. It is however important to note that many of these benefits could be realized without import of live animals with e.g. import of semen or embryos, with minimal risk of introducing new deceases if correctly carried out.

Considerable uncertainty surrounds all assumptions used in the cost calculations. Therefore, a sensitivity analysis, outlining the consequences of changing assumptions (spread of the diseases, prevalence, and reduction in products value) complements the cost assessment.

Calculation assumptions

The central assumptions for assessing the cost associated with introducing paratuberculosis are: probability of an infection, long-term herd prevalence, and the financial cost to infected herds. Each assumption will be discussed separately.

Probability of an infection

Dr. Preben Willeberg (2013) estimates the probability of paratuberculosis being introduced in Icelandic cattle in his report. He estimates the probability of at least one infected animal coming to Iceland given annual import from Denmark, using a simulation model. Two main sources of introducing the decease trough imports were developed in cooperation with Icelandic experts:

> a. Individual farmers import single bulls for improving their herd by cross breeding. This could be ca. 10 animals per year.
>
> b. Farmers start a pure-bred herd by importing ca. 20 cows and a single bull and then regularly import semen to improve the herd. There could maybe be ca. 5 occasions of such imports (per year).

Danish data is used to estimate the probabilities of an infection being introduced in Iceland as a result of importing cattle in the two ways mentioned above. Two scenarios of import patterns,

[1] See page 111 of Dr. Willeberg´s report

referred to as parameter sets 1 and 2, were developed from this based on different probabilities of sources a and b (see page 115 and table 65 in Dr. Willeberg´s report). We refer to these different parameter sets as scenarios 1 and 2. Willeberg´s results are the following:

Table 1 Simulated mean cumulated probabilities of entry of paratuberculosis to Iceland (from table 64 in Dr. Willebergs report – there called parameter sets 1 and 2)

Year	Scenario 1	Scenario 2
1	93,1%	82,9%
5	100%	100%
10	100%	100%
20	100%	100%

Table 1 shows a 100% cumulative probability of an infection being introduced by year five in both scenarios. The report does, however, not disclose marginal probabilities of an infection being introduced in each year. In order to estimate the probabilities during those years, a cumulative density function is fitted to the results. A simple logarithmic function is used with a constant. Figure one shows Willeberg´s estimates for the probabilities of an infection being introduced in years one and five in addition to an estimated cumulative density function.

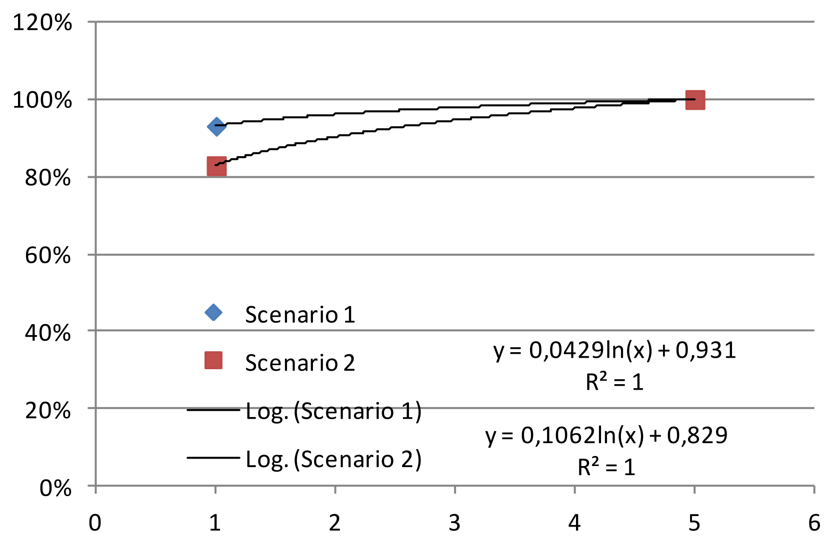


Figure 1 Estimation of probabilities of an infection being introduced in Iceland

The results of the estimation of the cumulative density function are shown in figure 1. A simple graphic differentiation of the cumulative density function is used to estimate the probabilities of an infection being introduced in years two, three and four (see results in table 2).

Table 2 Estimated likelihood of an infection being introduced in scenarios one and two

Year	Scenario 1	Scenario 2
0	0%	0%
1	93,10%	82,90%
2	2,97%	7,36%
3	1,74%	4,31%
4	1,23%	3,06%
5	0,96%	2,37%

As ca expected, the probabilities of an infection being introduced are greatest in the first year and significantly less in the succeeding years. As mentioned before, the cumulative probabilities of an infection being introduced by year five are 100% in both scenarios.

Herd prevalence

The spread of paratuberculosis depends on numerous factors. The main factors are: the number of infected herds, contact between herds, and hygiene. It can be assumed that the probability of a herd being infected increases as the number of infected herds increases. The spread of the disease can be reduced using classic means such as isolating animals of different farms from contact, strict hygiene requirements for possible carriers (inseminators, milk and cattle collectors…), inspection and education regarding the symptoms of the disease (Good at al., 2009).

Contact within cattle herds, between cattle herds as well as contact with sheep increases the probabilities of the spread of the disease. For example, the contact between calves and adult cattle can influence the spread of the disease because calves are vulnerable to infections from adults. Contact with herds from other farms increases the probabilities of infections as well as contact with infected sheep can increase the probabilities of infections.[2] Sanitary is an important factor to prevent the spread, e.g. at cattle births, in sties, and during transport. Furthermore, it is important to sanitize properly all equipment as paratuberculosis bacteria have a long lifespan (Good at al., 2009).

The spread of paratuberculosis varies between countries. In Sweden, the disease has neither been diagnosed in cattle nor in sheep and is not generally spread in Norway among cattle. Both countries have in place comprehensive and clear response and prevention plans. In Denmark, on the other hand, it has been estimated that paratuberculosis is present in 85% of all dairy farms. (Auður Arnþórsdóttir, Eggert Gunnarsson og Jón Viðar Jónmundsson, 2008).

The development of paratuberculosis in Ireland after entering the Single European Market

Some cases of paratuberculosis were diagnosed in Ireland between 1932 and 1992, in total 92 instances. Most of the cases involved imported animals. Despite the lack of data, the disease does not appear to have spread widely and established itself during that time period (Good et al., 2009). In

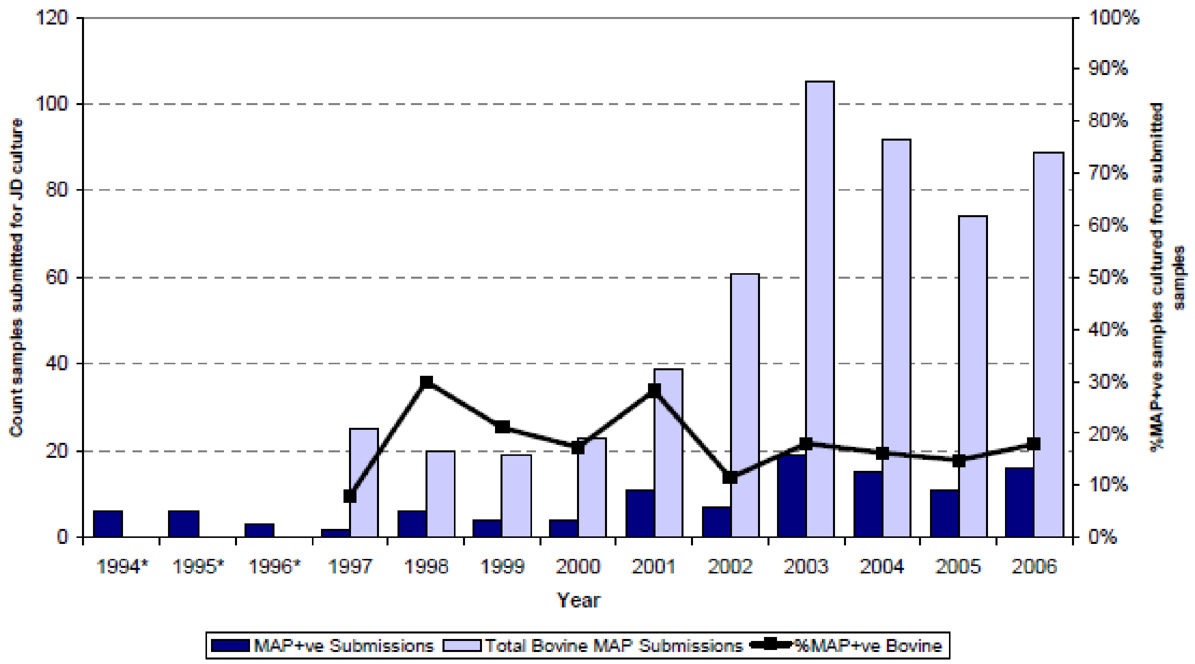
[2] It is worth emphasizing that we are only referring to paratuberculosis in cattle. The role of sheep is only as carriers of the infection.

1992, the introduction of the Single European Market led to lifting of import restrictions of live animals to Ireland. The country was forced to abandon its import rules regarding paratuberculosis pre-import testing, certification and quarantine procedures as the country became a part of the Single European market. As a consequence 85.000 cattle were imported from continental Europe from 1992 until May 2004. Most of the imported animals were for breeding and came from the Netherlands, Denmark, France and Germany (Good et al, 2009).

Between 1995 and 2000, the Department of Agriculture, Fisheries and Food received 232 notifications of paratuberculosis infected cattle in 106 herds. A serological survey in 1997 showed that out of 224 imported animals in 36 herds, 36% of the herds had at least one infected animal (Good et al, 2009).

Figure 2 shows the positive bovine submissions processed at the laboratory in Cork from 1989 until 2006 (Mee and Richardsson, 2008). The laboratory services Cork County and other neighbouring areas. The figure shows how a heightened general discussion regarding paratuberculosis resulted in increased number of submitted samples. The ratio of positive bovine submissions increases dramatically between 1997 and 1998 and the ratio is relatively stable around 20% between 2002 and 2006. According to Mee and Richardsson (2008), the pattern in figure 2 has been noticed elsewhere in the world by researchers.

Figure 2 Positive bovine submissions processed in Cork County´s laboratory. Source: Mee og Richardsson 2008



Paratuberculosis has established itself in Ireland after import of cattle was permitted. It is not clear why the prevalence of infected herds is lower in Ireland compared to other countries. The most likely reason is that the disease was introduced relatively late in Ireland compared to other countries because of the various national preventative rules in place until 1992.

An increase in the spread of paratuberculosis was detected in Austria after restrictions on import of live cattle were lifted there. Good et al. (2009) believe the prevalence of infected herds will rise until it becomes equivalent to the prevalence in other countries if preventative and corrective actions are not taken (Good et al, 2009).

Long-term herd prevalence in Iceland if import is allowed

The cost calculations are based on the assumption that if import to Iceland is allowed the long-term herd prevalence will be 35% of herds infected, roughly in accordance with the experience in Ireland, as discussed before. It is assumed that the spread from first case to full spread will take anywhere from 5 to 20 years. Given the uncertainty regarding the speed of the spread cost calculations are presented for 5, 10, 15, and 20 years from the introduction of the disease until the long-term herd prevalence is reached. It is assumed that the spread of the disease will be fast during the early years but slows down as the herd prevalence approaches the long-term levels.

Figure 3 shows examples of the herd prevalence rates given the before mentioned assumptions. A special section contains sensitivity analysis, including the effects of 20% and 50% long-term herd prevalence levels.

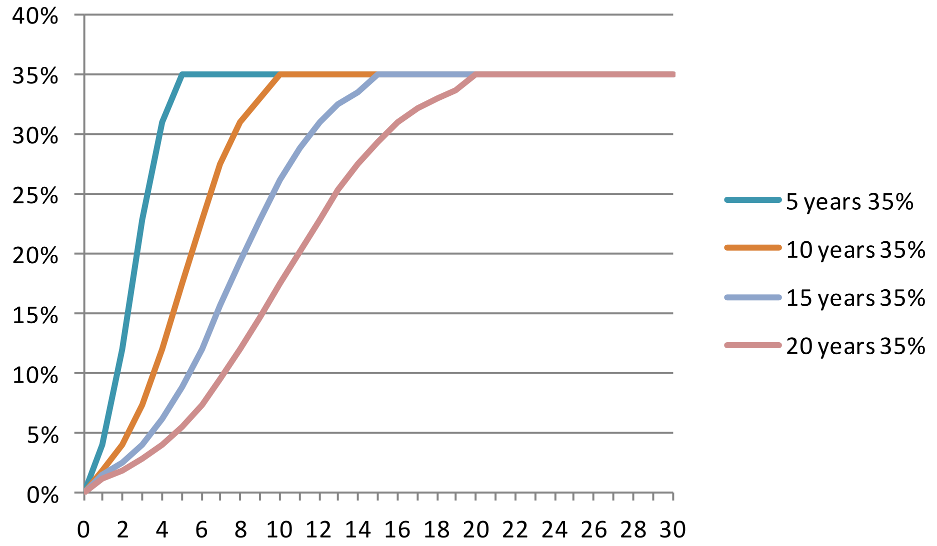


Figure 3 The development of herd prevalence rates given different time lengths from introduction until the long-term prevalence rate is reached.

The estimates for overall economic cost are the present value of total costs from introducing papatuberculosis taking into account the distribution of the time an infection is introduced, as discussed above. Figure 4 shows an example of how the disease might spread given different time before initial infection according to scenario 1, given the assumption that the spread takes ten years to reach a maximum of 35% herd prevalence. The probabilities of an infection being introduced in years one and five, as seen in table 2, are shown in the figure.

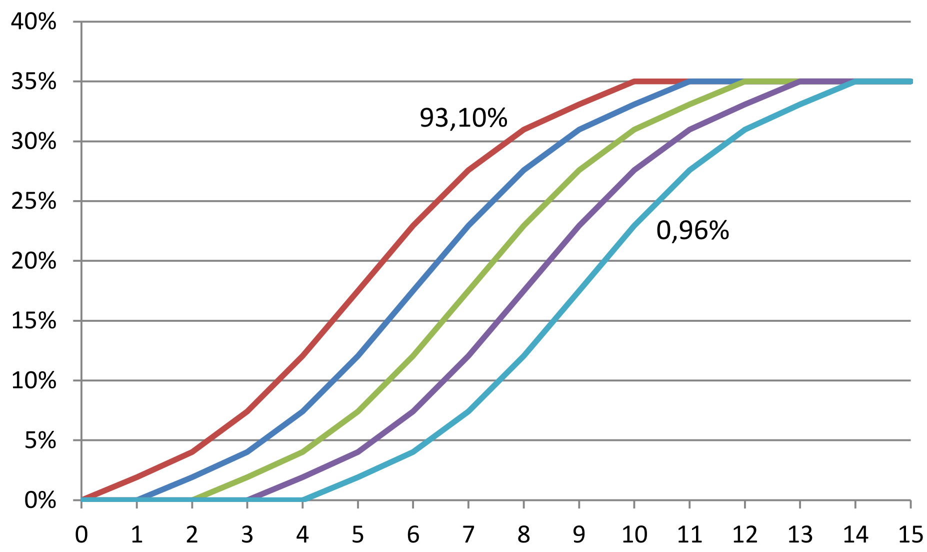


Figure 4 Examples of the development of infected herds given 10 years from the infection being introduced until 35% herd prevalence.

Effects on production attributes

Paratuberculosis has a negative effect on the production attributes of infected animals. The size of the overall effect depend on the number and spread of infected animals within a herd. The most important negative effects in dairy herds are lower milk production, lower fertility rates, less meat production as well as lower meat quality. In *Áhættugreining vegna garnaveiki í nautgripum á Íslandi* (Auður Arnþórsdóttir, Eggert Gunnarsson and Jón Viðar Jónmundsson, 2008) it is noted that the consequences for farmers in Iceland can be "insignificant up to serious" but the financial costs are not estimated. This analysis is therefore based on results found in the literature for similar production systems as the Icelandic to estimate the financial cost at the herd level. The relative reduction in production value in these studies is used as basis for the costs in Iceland. This relies on the assumption that the relative reduction in production value will be similar in Iceland.

Groenendaal et al. (2002) estimate the cost of paratuberculosis in the Netherlands on an average 50-cow dairy farm, increasing in size towards a 100-cow dairy farm in 20 years. The different sources of loss and the extent presented in table 3:

Table 3 Present value of total cost for a 50-cow Dutch dairy farm according to Groenendaal et al. (2002)

Reason	Losses(EUR)	Percentage of total
Milk-production losses and treatment costs	8.775	22%
Reduction in slaughter value	3.444	9%
Missed future income (sub-optimal culling)	27.026	69%
Total (20 years)	39.245	100%

Groenendaal et al.(2002) estimate the present value of financial cost over 20 years because of paratuberculosis in the United States on a 100-cow dairy farm to be $6.131. The results are based on the assumptions that the average annual production of a dairy cow is 9.072 kg and the price $0,287/kg. This gives an annual revenue from milk production of approximately $260 thousand. The cost due ot paratuberculosis is estimated at 1,89% of the annual revenue. If the effects are the same in the United States as in the Netherlands, then the reduction in production value due to loss in milk production and treatment costs are 0,42%, due to reduction in slaughter value and sub-optimal culling 1,3% and reduction in slaughter 0,17%.

The annual cost due to paratuberculosis has been estimated EUR 7.693 for an infected herd in Ireland. Given an average production capacity for a dairy farm is 9.000 kg per annum and a price of 0,35 EUR/kg, the average annual revenue is approximately EUR 315 thousand. The relative reduction in production value for an infected herd in Ireland is therefore around 2,44%. Given the same relative share of losses in Ireland as in the Netherlands, the reduction in production value because of milk-production losses is 0,85% and because of missed future income and reduction in slaughter value 1,59%.

A summary of the results of the three studies discussed before is presented in table 4:

Table 4 Relative reduction in production value because of paratuberculosis

	Netherlands	USA	Ireland	Average
Milk production losses Treatment costs	0,45%	0,42%	0,85%	0,57%
Sub-optimal culling Missed future income	1,38%	1,30%	1,59%	1,56%
Reduction in slaughter value	0,18%	0,17%		
Total	2,00%	1,89%	2,44%	2,17%

Bhattarai et al. (2013) conducted a recent US study of the awareness of veterinarians and producers about paratuberculosis. Both producers and veterinarians believed there was a cost was associated with paratuberculosis, both due to reduced production value as well as other inherent expanses. The following table shows the main results of the study:

Table 5 Cost because of paratuberculosis according to Bhattarai et al, 2013

Average annual loss for each infected animal	\$273-\$276
Lower weaning weight of calves from infected cows	\$76-\$123
Average annual loss in a 100 cow herd at 7% true prevalence	\$1.908-\$1.935

Weaknesses and uncertainty about assumption

Considerable uncertainty surrounds two of the main assumption this study relies on: long-term herd prevalence rates and the reduction in production value because of paratuberculosis. The cost calculations are based the assumption that the long-term herd prevalence is 35%. Examples of both higher and lower long-term herd prevalence level can be found in neighboring countries, as mentioned above. Factors such as common knowledge about the disease, regulations regarding import and contact, sanitary, sensitivity of blood samples and the quality of surveillance in slaughterhouses influence the estimates long-term herd prevalence (Auður Arnþórsdóttir, Eggert Gunnarsson og Jón Viðar Jónmundsson, 2008). The long-term prevalence is therefore determined to some extent by the environment the government creates as well the operating procedures farmers practice.

The cost calculations are to a large extent based on the experience in neighboring countries. Applying results from one country to another must always be done with care. It is however unavoidable given the lack of domestic data. Because of greatly varying product prices and yield levels between Iceland and the countries in table 4, cost is estimated as a share of production value rather than in terms of per herd or per animal annual cost. The sensitivity analysis is carried out to assess the effects of varying loss from 1,5%, to 2,5% reduction in production value.

The speed of the infections of the disease has cost implications as comprehensive measures need to be conducted earlier if the speed of the disease is faster. In this analysis it is assumed that there might be 5, 10, 15 or 20 years from the disease being introduced until the long-term herd prevalence rate is reached. As mentioned before, government´s and farmers´ preventative and corrective actions can influence the long-term herd prevalence as well as the speed of the infections.

The development of milk production in Iceland is uncertain. A reduction in production or production value can decrease the social cost of the disease while an increase in production and greater production values can increase the social cost. These possible developments are not accounted for in this analysis directly. It is worth mentioning though that these developments are accounted for to a limited extent in the sensitivity analysis by estimating the effects of the relative reduction in production value being 1,5%, 2,0%, and 2,5%.

Finally, stochastic factors and general uncertainty should be mentioned. These factors are inherently unpredictable and therefore impossible to consider them in the calculations. The stochastic factors as well as the general uncertainty can lead to higher or lower cost of paratuberculosis in Iceland.

The sensitivity analysis helps to map the uncertainty in the calculations. The cost calculations give a point estimate and the sensitivity analysis a lower and higher bound of the cost of the disease in Iceland.

The costs from an infectious disease occur over a long time period. It is important to realize that future cash flow are worth less than near term cash flow and, therefore, total costs must be brought to present value. The present value of costs due to an infection is based on long-term herd prevalence rate in each time period and the reduction in production value.

Cost estimates for paratuberculosis in Icelandic cattle

The cost associated with the risk of introducing paratuberculosis to cattle herds in Iceland by lifting the moratorium on imports of life animals is estimated as the expected net present value of a reduction in revenue from the year the moratorium on imports of live animals is lifted. A 5% discount rate is applied. Key assumptions are:

1. Probability of an infection being introduced in Iceland in year t_s is based on Willeberg´s (2013) results, as previously described, and for an infection in years two, three and four are estimated with a graphic differentiation of a fitted cumulative density function. The probabilities can be seen in table 6.

Table 6 Likelihood of an infection being introduced in time t_s, $P(t_s)$

Year	$P(t_s)$ Scenario 1	$P(t_s)$ Scenario 2
0	0%	0%
1	93,10%	82,90%
2	2,97%	7,36%
3	1,74%	4,31%
4	1,23%	3,06%
5	0,96%	2,37%

2. Based on the results from table 4 it is assumed that infected herds loose on average 2,0% of their revenue[3].

3. Long term herd prevalence is assumed 35% and spread follows an s-shaped pattern reaching the long term prevalence in between 5 and 20 years.

4. Present value of total costs if infection is introduced in at time t_s is the following:

$$NPV_{t_s} = \sum_{t=0}^{\infty} \frac{annual\ cost}{(1+r)^t}$$

where t is the year from year t_s and r is the discount rate.

The cost depends on the spread of the disease and is assumed zero for uninfected farms. The first infection follows the probability distribution described in table 6. In order to estimate the expected cost, the present value calculations need to be repeated given different assumptions regarding the time the infection was introduced. That is done by multiplying the cost from 4 with the probabilities of the infection being introduced in years 1 through 5. In mathematical terms, the cost calculation can are put forth as follows:

$$Present\ value\ of\ expected\ cost\ = \sum_{t_s=0}^{5} P(t_s) * \frac{NPV_{t_s}}{(1+r)^{t_s}}$$

where t_s is the year of introduction from the lifting of the moratorium and $P(t_s)$ is the probability of the introduction occurring in each year.[4]

An example of the cost calculations can be seen in Appendix 1.

Figure 5 shows an example of the development of costs of paratuberculosis where the long-term herd prevalence is reached ten years after the infection is introduced. The probabilities of the

[3] As an example, the annual costs given an annual total revenue from milk sales of 9330 m ISK and a long term herd prevalence is 35%, is: 35%*2%*9330 m. ISK.=65 million ISK.
[4] Note that it is unnecessary to calculate the probabilities for years where t_s>5 because for all years after year 5 the probability of introduction is equal to zero ($P(t_s) = 0$ for t_s>5)

infection being introduced can be seen table six. The total cost is near 65 million ISK annually when full prevalence is reached.

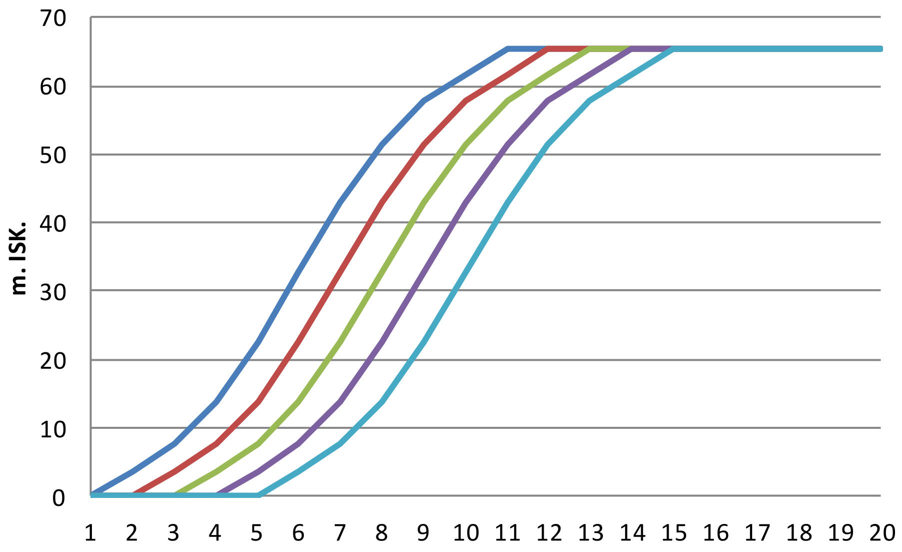


Figure 2 Examples of cost developments given various likelihood of the spread of infection.

Table 7 shows the present value of total costs of paratuberculosis in cattle herds in Iceland for the two scenarios and different speeds of spread:

Table 7 Present value of total cost (m.ISK) given 35% herd prevalence and 2% reduction in production value for the two different scenarios and speed of spread varying from 5 to 20 years

	5 years	10 years	15 years	20 years
Scenario 1	1.123	999	892	799
Scenario 2	1.112	989	883	791

As mentioned before, a 5% real discount rate is used. The annual cost equivalent from paratuberculosis[5] is shown in table 8:

Table 8 Annual cost (m. ISK) given 35% herd prevalence and 2% reduction in production value for the two different scenarios and speed of spread varying from 5 to 20 years

	5 years	10 years	15 years	20 years
Scenario 1	56	50	45	40
Scenario 2	56	49	44	40

The annual cost as a share of present value of production is shown in table 9:

[5] This is the present value times the discount rate.

Table 9 Annual relative cost given 35% herd prevalence and 2% reduction in production value for the two different scenarios and speed of spread varying from 5 to 20 years

	5 years	10 years	15 years	20 years
Scenario 1	0,60%	0,54%	0,48%	0,43%
Scenario 2	0,60%	0,53%	0,47%	0,42%

Tables 7-9 show that the present value of total costs is 800-1.100 million ISK based on the given assumptions according to current price levels. This is equivalent to an annual cost of 40-55 million ISK, or around 0,42%-0,60% of the annual production value.

It is also possible to base the estimate the on the results from Bhattarai et al. (2013). Around 25.000 dairy cattle are in Iceland (Hagstofa, 2013). Given 7% true prevalence and the cost for each 100-cow herd is $1900, the cost in Iceland can be estimated to be annually around 54 million ISK. The results from the US study are, therefore, at the higher bound of the cost estimates previously mentioned.

Sensitivity analysis

This section contains a sensitivity analysis in order to estimate the effects of varying the key assumptions about long run term prevalence and economic loss.

Figure 6 shows the development of infections where the long-term herd prevalence rate is 20% and is compared to the scenario where the long-term herd prevalence is 35%. The development of cost is comparable to the development of infected herds shown in the figure.

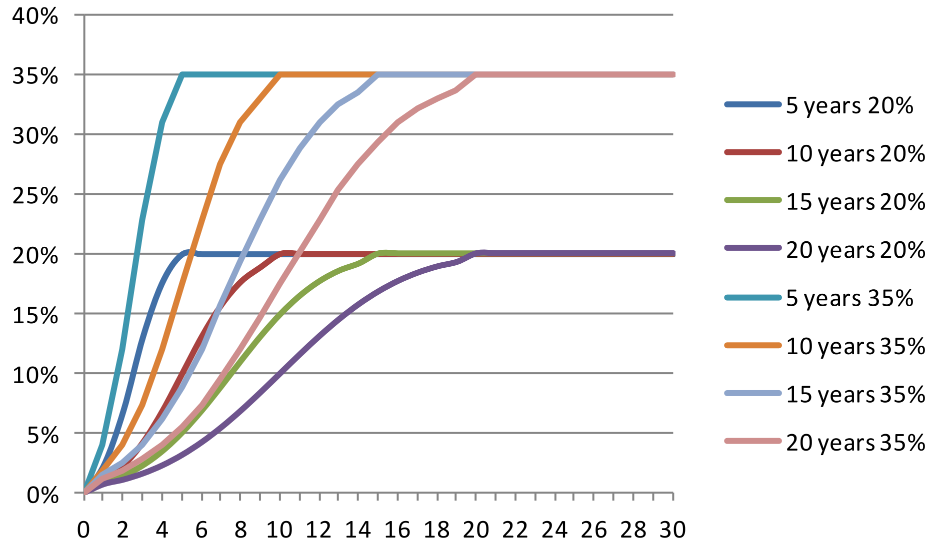


Figure 3 Examples of the development of ratio of infected herds

Tables 10-12 show the cost given 20% long-term herd prevalence rate and a cost reduction equal to 1,5%, 2,0% and 2,5% of the production value.

Table 10 Costs given 20% long-term herd prevalence and 1,5% reduction in production value

Present value of total cost (m. ISK)	5 years	10 years	15 years	20 years
Scenario 1	481	428	382	342
Scenario 2	477	424	378	339
Annual cost (m. ISK)				
Scenario 1	24	21	19	17
Scenario 2	24	21	19	17
Relative cost				
Scenario 1	0,26%	0,23%	0,20%	0,18%
Scenario 2	0,26%	0,23%	0,20%	0,18%

Table 11 Cost given 20% long-term herd prevalence and 2,0% reduction in production value

Present value of total cost (m. ISK)	5 years	10 years	15 years	20 years
Scenario 1	642	571	510	456
Scenario 2	635	565	505	452
Annual cost (m. ISK)				
Scenario 1	32	29	26	23
Scenario 2	32	28	25	23
Relative cost				
Scenario 1	0,34%	0,31%	0,27%	0,24%
Scenario 2	0,34%	0,30%	0,27%	0,24%

Table 12 Cost given 20% long-term herd prevalence and 2,5% reduction in production value

Present value of total cost (m. ISK)	5 years	10 years	15 years	20 years
Scenario 1	802	714	637	570
Scenario 2	794	707	631	565
Annual cost (m. ISK)				
Scenario 1	40	36	32	29
Scenario 2	40	35	32	28
Relative cost				
Scenario 1	0,43%	0,38%	0,34%	0,31%
Scenario 2	0,43%	0,38%	0,34%	0,30%

Given a 20% long-term herd prevalence level, the cost is between 340 and 800 million ISK, equivalent to around 17 and 40 million ISK annually. The cost as a share of the current production value is between 0,18% and 0,43%.

Tables 13-15 show the cost of the disease if the long-term herd prevalence rate is 50% and the reduction in production value is 1,5%, 2,0% and 2,5% compared to current production value:

Table 13 Cost given 50% long-term herd prevalence and 1,5% reduction in production value

Present value of total cost (m. ISK)	5 years	10 years	15 years	20 years
Scenario 1	1203	1070	955	856
Scenario 2	1192	1060	946	847
Annual cost (m. ISK)				
Scenario 1	60	54	48	43
Scenario 2	60	53	47	42
Relative cost				
Scenario 1	0,64%	0,57%	0,51%	0,46%
Scenario 2	0,64%	0,57%	0,51%	0,45%

Table 14 Cost given 50% long-term herd prevalence and 2,0% reduction in production value

Present value of total cost (m. ISK)	5 years	10 years	15 years	20 years
Scenario 1	1604	1427	1274	1141
Scenario 2	1589	1413	1262	1130
Annual cost (m. ISK)				
Scenario 1	80	71	64	57
Scenario 2	79	71	63	57
Relative cost				
Scenario 1	0,86%	0,76%	0,68%	0,61%
Scenario 2	0,85%	0,76%	0,68%	0,61%

Table 15 Cost given 50% long-term herd prevalence and 2,5% reduction in production value

Present value of total cost (m. ISK)	5 years	10 years	15 years	20 years
Scenario 1	2005	1784	1592	1426
Scenario 2	1986	1767	1577	1412
Annual cost (m. ISK)				
Scenario 1	100	89	80	71
Scenario 2	99	88	79	71
Relative cost				
Scenario 1	1,07%	0,96%	0,85%	0,76%
Scenario 2	1,06%	0,95%	0,85%	0,76%

Given a 50% long-term herd prevalence rate, the cost is between 850 and 2000 million ISK, or between 43 and 100 million ISK annually. The estimated cost as a share of current production value is between 0,46% and 1,07%.

Results and summary

This analysis aims to estimate the cost of introducing paratuberculosis in cattle in Iceland by lifting the moratorium on live animal imports. Analysis is based on estimates for the probability of introducing the disease in Iceland if the moratorium was lifted, as well as the experience from neighboring countries, especially Ireland, regarding spread, long-run prevalence and revenue losses.

Based on this information the estimated present value of total cost because of paratuberculosis is between 800 and 1.100 million ISK, using a 5% real discount rate. This is equivalent to an annual cost of between 40 and 56 million ISK , or a loss of between 0,43% and 0,60% of the current production value of milk and meat.

Considerable uncertainty surrounds key assumptions. Sensitivity analysis provides an insight into the effects of higher and lower values of these assumptions on the cost of the disease. The results indicate that the present value of total costs lies within a quite wide range, or between 340 and 2.000 million ISK. The annual cost is therefore between 17 and 200 million ISK and the relative cost reduction between 0,18% and 1,07%.

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Appendix 1

	Cost (m. ISK)				
Year	Infection in year 1	Infection in year 2	Infection in year 3	Infection in year 4	Infection in year 5
0	0	0	0	0	0
1	8	0	0	0	0
2	23	8	0	0	0
3	43	23	8	0	0
4	58	43	23	8	0
5	65	58	43	23	8
6	65	65	58	43	23
7	65	65	65	58	43
8	65	65	65	65	58
9	65	65	65	65	65
10	65	65	65	65	65
11	65	65	65	65	65
12	65	65	65	65	65
13	65	65	65	65	65
14	65	65	65	65	65
15	65	65	65	65	65
16	65	65	65	65	65
17	65	65	65	65	65
18	65	65	65	65	65
19	65	65	65	65	65
20	65	65	65	65	65
⋮	⋮	⋮	⋮	⋮	⋮
∞	65	65	65	65	65

Value (m. ISK)	9330				
Cost share	2,00%				
Probabilities #1	93,10%	2,97%	1,74%	1,23%	0,96%
Probabilities #2	82,90%	7,36%	4,31%	3,06%	2,37%
NPV	1130	1076	1025	976	930

Present value of total costs in scenario 1	1123
Present value of total costs in scenario 2	1112